BIO-DYNAMICS

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THE BIODYNAMIC TREATMENT OF FRUIT TREES, BERRIES, AND SHRUBS

Part Two

EHRENFRIED E. PFEIFFER

Fertilization of an Orchard

Biologically, the fruit tree stands between the forest tree and the cultivated field plant. It has the long-cycle of growth in common with the forest tree. Like all forests, the orchard needs humus. Like all cultivated crops, it needs a well-aerated and fertilized soil and much care. The chief troubles of orchards are results of deficiencies, which can also come about because of over-fertilization. These include especially the trace mineral deficiencies, and all may be absolute or relative, the latter being caused by tying down (unavailability) resulting from a one-sided, unbalanced fertilizer program.

All fruit trees are sensitive to over-fertilization with nitrogen. It is true that trees may develop more foliage because of an excess of nitrogen, and even have more fruit; but because of the imbalance the fruit may not keep as well, the blossoms may drop, diseases and pests may be fostered, and the sugar content may be reduced. In order to develop sugar, and carbohydrates in general (cellulose is a polymer), the tree needs potash. The extensive root system has more ability to get at the mineral nutrients and to make them available than does the annual plant. Nutrients therefore need not necessarily be offered in the easiest and fastest available form. This is why we prefer slower release of nutrients, as is the case in well-composted manure and compost in general. Here the soil microlife and the natural, stable humus content is of importance for ready availability and lasting fertility. Lasting fertility is the main factor because of the prolonged vegetation period. Quick availability, for instance in Spring before emergence, would only cause more blossoms to drop, while the growing and especially the maturing fruit remains undernourished.

Humus is the balancing factor which "holds" the nutrient as well as the moisture. For the ripening fruit still needs nourishing sap at a time when most field crops are already harvested or dried up. That a tree needs lasting fertilizer is frequently overlooked. Fresh manure is not suitable for trees for the

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reason that it is too easily available and its excessive nitrogen can bring bad results. In recent years a kind of nitrogen craze has developed. That the increase of pests and disease might be a result of unbalanced fertilization and lack of humus supply is something that has not occurred to many so-called expert orchardists.

To run to the orchard with a spray gun should never be considered progress. Rather, the need for so many sprays — in fact manifold times more than 20 years ago — is an alarming symptom of the disturbed balance, besides being an expense and a nuisance. It needs a reversal of thinking and habits to realize that spraying expense; which is a negative procedure, should and could be replaced by positive, constructive action, namely soil cultivation (aeration), the building up of humus, and tree care. Only after all biological measures have been fully employed will the time come that healthy trees are again grown and that the total expense of an orchard can be sizably reduced. But in the meantime the orchardist should always keep in mind the question as to whether he is applying wasteful, negative procedures, or constructive ones.

After these preliminary remarks, some fertilization procedures will be discussed. The importance of the preparation of the "seed bed" has already been described. It is said that a full-grown tree in good cropping condition needs from 2 to 3 pounds of nitrogen a year. This rule is based on the use of nitrogen fertilizer with relatively fast release of nitrogen, and on the fact that such fertilizers are about 25% efficient. To be on the safe side, we recommend compost and organic fertilizers, including composted manure and aerated sludge, containing 1 to 2 pounds of nitrogen per full-grown cropping tree. These composts usually contain phosphates, potash, minor elements and trace minerals according to a general formula of 1-1-1 or 1-2-1 or fractions or multiples thereof. It is not necessary, when using organic fertilizer, to use a formula containing more than 2 or 3% nitrogen. It has however been our experience in recent years that compost in the long run will not supply all the potash that is needed.

Here, in connection with our discussion of fertilizing, let us insert a table of suggested planting distances:

Trees	feet	trees per acre
Apple	35	36
Cherry, sour	18	135

Cherry, sweet	20	110
Peach	20	110
Pear	20	110
Plum	20	110

Berries	feet between rows	feet apart in rows
Blackberries	6	6
Black Raspberries, garden	4	3
Black Raspberries, field	7	4
Dewberries	4	5
Grapes	8	8
Red Raspberries, garden	4	3
Red Raspberries, field	7	3
Strawberries	4	1½

Trace Minerals

These should not be neglected. In compost, especially if many weeds and leaves are incorporated, all trace minerals usually are present. Tall biennial and perennial weeds, and weeds that appear chiefly during summer and fall are richest in minerals. However, one nevertheless occasionally finds deficiencies of boron, zinc, copper or magnesium.

Boron is readily available in shales, clay of marine origin and, above all, in organic matter. Its availability is reduced by liming and drought. It might increase to a toxic level, by irrigation with boron-containing water, f.i. in California. 10 to 20 ppm in a soil is good, 4 ppm low, 30 ppm already toxic. Three to 5 pounds of borax per acre, applied as a spray or, better, mixed with compost, is sufficient. Important boron deficiency symptoms in apples are: defoliation and terminal rosette formation in shoots; bark rough and split; malformed fruit with cracks and pitting.

Manganese deficiency on apples, cherries and plums, and on black and red currants: intervenal chlorosis of leaves, beginning near margin and progressing towards midrib, all over tree, but young shoots may still show green leaves. On pears also a slightly faded green.

Magnesium deficiency on *apple*: shoot growth normal to zero, severe intervenal necrosis of leaves towards end of season, purpling, defoliation of terminal shoots, fruit fails to ripen in this case. On *cherries*: dull purple on leaves, followed by red-orange, brown necrosis in older leaves, early defoliation. On *pears*: very dark brown older leaves, intervenal necrosis near center while margin remains green (opposite to manganese de-

ficiency). On *black currant*: central area of leaves, beginning with older ones, shows intense purple color, narrow band near margin remains green, tinted leaves curling backward, early defoliation. On *gooseberries*: slightly pale leaves, broad red margin bands, fading to cream; defoliation early. On *raspberries*: older leaves, center and margin yellow or red with green band separating. Marked chlorosis, intervenal, early defoliation. On *strawberries*: older leaves bright yellow and red, center and margin. On *grapes*: older leaves intervenal chlorosis (green grapes), or strong purple or red (blue-black varieties), narrow green margin band, brown intervenal necrosis, early defoliation.

Nitrogen and phosphorous deficiency we need not discuss here because they should not occur in a well managed biodynamic orchard with sufficient organic matter supply. Occasionally there may be *iron* deficiencies. In apples and pears this may take on serious dimensions, when branches die back and fruit is highly colored. Raspberries are quite susceptible to iron deficiency. In biodynamic soils in this country we have not yet encountered an iron deficiency. Pale brown or black soils are suspicious in this regard.

Zinc deficiencies are mainly seen in citrus fruit. Here a foliage spray is most successful. Only minimal quantities are needed. Mottled leaves are the symptom. These show also on apples and stone fruit, as well as little leaf or rosette, accompanied by pigmentation changes, malformation of leaves, sparsity of foliage and reduced fruit production.

Copper deficiencies show up as exanthema or "die back" of citrus, apples, pears, plums; shoots die back, foliage shows "burning" of leaf margin or chlorosis; rosetting and multiple buds occur and gum bleeding occurs.

Sulphur deficiencies are rare in biodynamic soils, but may occur in sandy soils and then resemble somewhat nitrogen deficiency symptoms and sometimes show orange and red tints on the foliage of apples, gooseberries and strawberries.

Potash deficiency is important in the case of fruit trees and easily recognized in apples, gooseberries, red currants and raspberries by stunted growth, "die back" of shoots, bluish green leaves and especially scorching of leaves on the margin. Plenty of blossom buds but little fruit of poor quality, tasteless. In plums, peaches and cherries chlorosis and forward rolling of leaves may develop in addition. Potash deficiencies, one regrets having to note, are frequently seen in biodynamic and organic culture, due to an error in composting. The potash content of

the compost is frequently over-estimated, and repeated applications of such composts with a low (0.5 to 0.7%) potash content have gradually caused a potash deficiency in spite of the apparent building up of humus. For the grower to proceed safely, we always recommend an NPK analysis of the compost, so that he may use the proper and adequate amount, or make corrections. Details on all the deficiency symptoms can be read in two excellent books: "Hunger Signs in Crops", a symposium published by the American Society of Agronomy and the National Fertilizer Assn., Washington, D. C., 1941; and T. Wallace's "The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms", Chemical Publishing Co.; Inc.; New York, 1953.

Green Manuring and Cover Crops

These are good practices in orchards, in order to build up the effects of the organic method in the soils. This brings up a question frequently discussed: open cultivation, or no cultivation at all. There can be no dogma in these matters, both have their place and will fulfill their purpose if done with understanding.

In the old world we frequently find a combination between a meadow or pasture and an orchard. The trees are planted into the meadow and as long as they are small the hay is mown and harvested. Under full-grown trees the cattle and sheep can pasture. Where land is scarce, on steep slopes which do not permit much plowing or cultivation, and on very heavy clay soils which do not yield to the plow, this practice has its benefits.

With the increase of toxic sprays, the pasturing of livestock is of course impossible. Furthermore, the increase of commercial orchards separated from other farming makes the meadow orchard obsolete. Green manuring and cover crops are a substitute for the long-lasting rest period the soil would otherwise have when meadows are developed. One should be guided by the structure and behavior of the soil, and the needs of the trees. There is no doubt that "no" cultivation, as is frequently the practice in citrus orchards, has beneficial effects with regard to soil building. It has its place where soils are difficult to handle, organic matter is deficient, and the climate is warm and apt to destroy organic matter through heat and drought.

Once the root felt of weeds, grasses, etc., becomes so thick that no air and water can penetrate and circulate, the soil gets water-logged or develops a separating layer between topsoil and subsoil, eventually increasing in acidity and anaerobic bacterial life. In such a case the "no" cultivation has been overdone.

Speedy turning under, breaking of the soil, cultivation, are necessary. Then an alternating of "open" years and cover or green manuring crops must follow. We recommend not falling into extremes but moving along a middle line. Constant open cultivation over many years will gradually break down and reduce organic matter, even to the point where it is too costly to repair the damage. This is especially the case where the soil is light, sandy (Florida), or exposed to much warmth and drought.

Permanent cover crops are: clovers, alfalfa and pasture grasses. These have to be selected according to soil type and climate. Temporary cover crops are: biennial clovers, such as mammoth clover, red clover, incarnate clover — buckwheat on light, sandy soil for a quick turning in. An ideal combination is a mixture of red clover and mustards. Mustard sweetens out a soil but can become a terrible weed. This cover crop should be mown in time, so that the mustard cannot go to seed. The hay can be used for mulching or composting. The compost can then be returned when the cover crop is plowed or disked under for a fallow period. It is always good to top dress the cover or green manuring crop with compost immediately prior to turning under. If, at the same time, the B.D. Field Spray is applied, the green manuring crop will be broken down fast without tying down nitrogen. Several cultivations can follow and then a few months or a year of plain fallowing. If irrigation ditches have to be established and water runs to be maintained, the practice of green manuring needs proper timing in order not to interfere with irrigation. Sprinkler systems have the advantage that they do not interfere with cultivation. With the introduction of portable aluminum pipes this problem is solved. Care should be taken, though, that the sprinkler system does not spray and hit the foliage on a hot and dry day. The water should be sprinkled *underneath* the tree. Drenching with water should be avoided. Sprinkling with large drops of water under force may harden and encrust an open soil surface. Either, surface cultivation ought to follow to break the crust, or a finer spray should be applied. One can very well irrigate green manuring crops. The cultivation, mowing of cover crops, and irrigation needs a level or well-levelled graded land with as few un-evennesses, ridges, etc., as possible. This grading should be done before the orchard is planted; later on it will be difficult.

Cover crops are much needed during the interim phase of the young growth when the trees do not as yet shelter the soil. Inter-crops with vegetables are possible at this time too.

Now a word about *mulching*. We draw a distinction between a merely protective mulch and a nourishing mulch. The function of the protective mulch is just to cover, to hinder moisture losses and weed growth. This can be done with anything which covers, even paper — best is with chopped straw or hay. Also salt hay, leaves, bagasse (stays dry), sawdust or wood chips — the two latter produce an acid soil. After its function is fulfilled, the mulch can be disked under, or else it should be removed. New mulch should not remain over winter so that mice and rats can build tunnels underneath and attack roots and trunks. Also, the frost action is so beneficial to soil structure that it should not be hindered by letting the mulch lie over winter in a Northern climate. The author feels that mulch used in order to hinder evaporation during the hot and dry season is quite beneficial and important. Mulch in wintertime is a double-edged affair. If it hinders moisture from reaching the ground and penetrating, it has missed its purpose.

No mulch should ever come near the trunk and grafting scar. Air should have access at all times to these places, otherwise serious damage to the air bark will occur and pests may hibernate there. As a general rule, mulch should be kept one to two feet away from the tree. Much damage has been done by not observing this rule.

The second type of mulch, as mentioned above, is the nourishing mulch. This is made with half-rotted compost. It is not applied as thickly as the straight cover mulch. The compost should have lost at least some of its "rawness" (decay of fresh material), especially when green plant parts of vegetables are used. Leaves need not be well rotted for mulching. This nourishing mulch may last only a few months, and should be disked under after it has fulfilled its function. This is best done together with an application of the B.D. Field Spray. Such a mulching procedure will not completely cover the nutritional needs of the trees or berries, and requires a compost supplement. The compost is applied on top of the mulch immediately prior to the plowing or disking under.

So-called sheet composting of raw materials we cannot advocate, for it is apt to spread disease and vermin. After all, neither orchards nor vegetable gardens are proper sites for "spread out" garbage dumps. Excessive mulching, which packs down and excludes air circulation can choke out feeder roots underneath the surface. We remember one case specifically,

where the grower had applied a heavy mulch of sludge. Digging a soil profile, we found the feeder roots were not reaching the surface soil but were some 8 to 10 inches below the top. There was lots of moisture and humus just below the mulch, but the soil strata had separated and no nutrients of the top soil would reach the feeder roots.

Whether your mulching and cultivation practice is right or wrong is something you can easily detect when digging for feeder roots. These should come up to the surface. If they don't, something was wrong in what you have been doing. The more feeder roots nearer the surface, the better.

There is one mulch which is especially beneficial, alfalfa hay. This hay can be used as is; preferably it is shredded or chopped in one to two inch lengths and slightly rotted. Old trees can be regenerated and many deficiencies corrected with it. The expense of even $50 for one ton of such hay is money well invested. We met an eighty-year-old citrus grower who told us that his father had used the alfalfa mulch as a remedy, and he did so too when trees began to show poor foliage and small fruit. This mulch need not be applied every year but only once in a while, perhaps every 5 or 10 years. It will rejuvenate the trees. This is a dual purpose mulch, protective and nourishing. Once the hay is completely rotted, the remainder can be disked under.

Pollination of Blossoms

Bees, bumblebees and other beneficial insects belong to an orchard. Less well known is the necessity for "rooster" trees, which supply the pollen for cross-pollination. Reliable nurseries have available, lists of "rooster" trees for the varieties being planted. No suggestion regarding varieties can be made here, for this question depends too much on soils, climates, local conditions and, last but not least, individual taste and market requirements.

Mixed Culture Instead of Monoculture

It is evident that a pest will spread much faster and more easily if it is provided with a good "hunting" ground. If we have 10, 30, 50, 100 acres of one variety, pests will spread out that much faster. Insects are highly specialized and certain ones will attack one type of fruit more than another and one variety more than another. The more mixed the stand is, the better for its biology. A completely mixed stand of different varieties and different species is biologically certainly the health-

iest. Alas, economic considerations, labor, practices of spraying and cultivation, interfere with the ideal.

We see the biological advantage of a mixed stand in a forest, where hard woods and soft woods together grow better and produce better humus than a monoculture. The roots penetrate into different strata of soil and support rather than compete with one another. Also there are various beneficial and antagonistic interactions between root systems, even between the trees and the annual plants which grow around them. Nasturtium, growing between fruit trees transmits a "flavor" to the tree which is entirely disagreeable to aphis. (Even a washing of the tree with nasturtium juice and especially of the internodes of the twigs, where the aphis nests, helps to protect against them.)

Much too little is known as yet about beneficial or hindering interactions, otherwise we would make more definite suggestions. We would like to call to the attention of our readers the advantage of making observations in this field and reporting them.

For practical reasons a compromise between monoculture and mixed culture can be made: plant double, triple or quadruple rows of one variety or species, and alternate with double (etc.) rows of other varieties and species. For instance, set 4 rows of apples subdivided into 2 rows each of two different varieties, then 2 to 4 rows of pears, then 4 rows of peaches. The spray rig going through the row, or the harvest truck, or any cultivation process, can be used simultaneously for the double row of a kind.

The Crown Drip and the Root System

It should be realized that the root system is a replica of the tree crown. As the tree branches out, the roots fan out. Dying back from the tips of the shoots and twigs indicates damage of the root. Recent research has shown that on naturally grown trees, the individual root "branch" supplies the tree branch directly above it, the sap carrying vessels leading straight up to that branch. On grafted trees this anatomical correspondence is less evident. The feeder roots are, or should be, right underneath the crown drip and from there on outward. No feeder roots (of a full-grown tree) are near the trunk. Any application of compost, mulch, etc., and any cultivation or aeration, even irrigation, should be applied in a space from about 2 feet inside to 2 feet outside of the crown drip, i.e. underneath the

outer confines of the crown. All these measures should stay away at least 2 feet from the trunk in older, and 1 foot in younger, trees. The cultivation of the interspace between rows, or the cultivation ring around solitary trees is, therefore, important. On can also proceed in such a way on an orchard-meadow combination, cover crop or no cultivation, that one breaks a row or two, one year nearer to the tree and one year farther to the outside of the crown drip, going through the orchard in checkerboard fashion.

The orchardist should be fully aware of the root pattern of his trees in order to apply the right practice at the right time. Apple trees, for instance, grow a deep-growing tap root for the first 9 years. Then the horizontal branching begins to fan out. Mulch and compost should by that time be placed outside from the crown drip, to encourage the spreading feeder roots. The pear tree has a more close system of roots, and mulch and compost spread underneath and inside the crown drip will be more effective. If a tree is strong on one side and under-developed on the other, it means also that the root is under-developed on the weak side.

Now a word about special care of solitary trees (of any kind) which may stand on the lawn near a sidewalk, or otherwise in a position which does not allow for mulching or cultivation. This may perhaps be a tree with special associations, which one wants to rescue. In such cases we have recommended making holes with a crowbar, just inside and outside the crown drip. They should be about 18 inches deep, and widened to about 2 inches in diameter by poking and twisting with the bar. These holes are made all around the tree, at distances of 2 feet from one another, and can then be filled with well rotted compost.

Plant Diseases

The danger of many fungus diseases can be reduced if stagnant air moisture is avoided. The wind should strike freely through the orchard. A closed-in stand will always cause difficulties. The trees should be well trimmed and get all the light they can through all parts of the crown. Too close a stand or one too near a wall or house will encourage fungus infection, mildew, blight, rust, etc. Frequently one sees trees and shrubs too close to a house. The planter did not realize the size of the full-grown tree or shrub when planting. Espalier should stand at least a few feet away from the wall and not be trained along the wall but on a free-standing support. Roses and vines will

be the more mildewed the nearer to a wall they grow, for they can't take the reflected heat and the moisture which builds up there. (The latter is not good for the wall either.) Grapevines especially, are sensitive to standing and excessive air moisture. A location in a damp hollow in the reflecting area of a lake has a lot to do with such a condition. Again, rambler roses on the southeast corner of a house will be mildewed, while on any other corner they may do well. As we have said before, the spray gun does not solve the problem of improper position.

No dead, fallen fruit should ever be allowed to remain underneath the tree, for it will always spread infections. Such fruit, as well as disease-dropped leaves, should be composted and the compost should be well decomposed and earthy before it is reapplied to the orchard. Monilia-infested fruit frequently remains on the tree, shrivels and hangs there still the next year. All monilia-infested fruit should, under all circumstances, be removed at once and be burnt.

Fortunately, industrial sprays against diseases have not been developed to the extent of the insecticides. The grower is apt to use biological principles for lack of a poison.

Some organic phosphorous and fluoride compounds are offered for use against plant diseases. They have the disadvantage that they are poisonous to enzymatic processes in man, animal and the plant itself. As stated before, biological control is preferable to chemical control. The relationship between the host of fungus diseases and the infected tree or shrub is something that should be much more realized by the orchardist. The most famous example is in another field of agriculture: the stem rust of wheat, oats, rye and grasses, for which the Berberis (barberry) shrub is the alternate host. No such shrubs, therefore, should be allowed in the neighborhood of grain fields. In orchardry we have the cedar-apple rust, with a red cedar as alternate host, the blister rust on five-needle pines, for which currants and gooseberries are the alternate host.

Poor and unprotected pruning cuts, and any bark lesions, are particularly susceptible to fungus invasion and rot, and should be immediately covered with the tree paste. Canker on apples and pears is caused by a fungus, Septobasidium pedicellatum — use the tree paste. White rot appears on fruit, nut and shade trees, hence the latter, if in the neighborhood of fruit and nuts should also receive biological treatment. The mycelium and perithecia of the apple scab fungus grow and propagate in

dead leaves, so sheet composting and mulching with dead leaves are great ways to spread the scab fungus. All dead leaves should be collected, as well as dead, dropped fruit, and very well composted to an earthy compost structure. Leaf spot on cherry and plum, blight on stone fruits, grey mold or botrytis blight on buds, fruits and roots, blue mold on apple, pear or citrus, are caused by fungi imperfecti and can be combatted with tree paste and equisetum spray.

Much valuable information about pests and diseases can be found in "Elements of Plant Protection" by Louis L. Pyenson, published by John Wiley & Sons, Inc., New York. Since we do not object to sprays of non-lasting organic poisons, extracted from the plant realm, as an intermediate or conversion measure, it is important to know under what conditions the effects of these sprays are enhanced or counter-acted. Nicotine, highly toxic in concentrated solution, should be mixed with soap or detergent solution in order to penetrate the waxy layer of the insect skin, especially aphids. Its residual toxicity is about one day to one week. It becomes more effective if hydrated lime is added, while rotenone and pyrethrum become ineffective in alkaline solutions.

Predatory insects are: lady beetles and their larvae (against aphids and scale), lacewing flies and their larvae, the so-called aphid lions; syrphid fly larvae (against aphids); nocturnal ground beetles and their larvae; tiger beetles, the praying mantis, robber flies, predaceous bugs in general, and spiders. Shrews, skunks, bats, snakes, newts, lizards, toads are welcome in an orchard. Insects, especially their larvae, can also have parasites which eventually destroy them. Certain wasps lay their eggs into other larvae. The Oriental fruit moth has a parasite, Macrocentrus ancylivora, and the egg parasite Trichogramma minutum attacks many insects. The orchardist does well to brush up on his knowledge of all these things. It is beyond the scope of this short outline to present all the details. It is, however, our firm belief that the measures described in this article will, if carried out with consequence, enable the grower to have a healthy orchard and shrubs.

Berries

Finally, a word needs to be added about berries. Contrary to the erroneous belief that these will "do by themselves" and therefore need no specific attention, berries require much cultivation, i.e., well cultivated, aerated soil, and good fertilization.

Berries belong to the group of heavy feeders. Well-rotted manure and rich compost is only just good enough for them. Berries are really "row" crops. The interspace between rows needs frequent cultivation. Mulch (protective) can be applied during the summer but, before the mulch is spread, a heavy dressing with compost and/or manure is needed.

This applies especially to grapes. One very successful system for grapevine cultivation has produced some of the very best wines of France:

Two rows of vines close together with a wide interspace for cultivation and clover or alfalfa as intercrop, one or two years of intercrop and one year of open cultivation alternating.

Mulch should be worked under or removed in fall, and the soil should be loosened. No moss should be allowed between the rows. As with fruit trees, compost and manure are applied most favorably in early spring when the roots begin to grow new feeder roots, but not to be used from blossoming to fruiting. All organic material should be well rotted. Old wood and shoots or runners have to be cut back. Diseased plants should be removed at once and not allowed to spread diseases. The tree paste is sprayed over the whole plant.

Berries have their life cycles too. Grapes, for instance, have a life cycle of about 44 years. New areas should be planted before the life cycle of the old growth has expired. Cuttings should be removed and not left lying underneath the shrubs. It makes no sense to see the cuttings lying about covered with fungi and at the same time try to combat fungus disease on the shrubs. Berries which stand at 6x6'x interspace, need about 30 lbs. of compost to each plant. Deep cultivation with a subsoiler from time to time in the interspace between the rows is quite helpful. This should be done in late summer or in fall, but not in spring and early summer.

It is important to realize that trees and berries are perennial plants and that next year's budding is prepared in this year's spring. All measures carried out in spring, up to May, have already influenced the foundation for the bud of next year. Long term planning in orchard culture is necessary, results should, therefore, not be expected from one day to the next.

BOOK REVIEW

BOTANY, *An Introduction To Plant Science by Wilfred W. Robbins, T. Elliot Weier, and C. Ralph Stocking. John Wiley & Sons, Inc., New York, 1957.*

This is a revised and enlarged edition of a book which was first published in 1950. In comparing it with a college Textbook of Botany which appeared in 1934 one is struck by an interesting trend in point of view, or rather attitude toward plants. In the first place, this new volume is dedicated to the first of the listed authors in these words: "for him botany was alive, human, to be used and enjoyed by himself and his students, in classroom and out; in agricultural specialists' offices and on their experimental plots, and by commercial growers and home gardeners." A further quotation from the Preface re-emphasizes this change: "The authors believe strongly that the significance of botany lies in its being that area of plant science which integrates and adds to the store of basic knowledge about plants, and from which must be drawn by amateurs and professionals alike, all of the details which make gardening a pleasure and agriculture the single most important industry in the country." In discussing changes made in this edition the authors write: "Two major changes have been made . . . , both designed to emphasize the fact that the plant as a whole is a living, functioning organism. Function and structure comprise a unit, understandable only in terms of each other. To this end, as in the first edition, the general functions of structures are discussed as the structures are first described."

There is, however, a curious contradiction in terms which comes out most clearly in the fifteenth chapter: The Plant as a Living Mechanism. They refer to the danger of losing sight of the *organism as a whole* in one's preoccupation with the details of the separate parts, they speak of the plant as being more than a "collection or colony of cells." Yet in the end they go on to say that "these cells are 'put together' and interrelated in such a way that they form a smooth-working living mechanism — an organism." However, it is a beautiful book despite these minor discrepancies, profusely illustrated with diagrams, photographs, some in color and innumerable others in black and white.

Much interesting information is there to be gleaned. In a discussion of vitamins they refer to the fact that most plants produce their own vitamins, while very few of the animals are

capable of this and even those in a very limited sense. Thiamin, for instance, is necessary to the growth of the root, yet the root cannot produce it. It is produced in the leaf and transported to the root. Here light is the essential factor, just as it is in photosynthesis. Then there are the various factors which do not play an active part in processes but act as catalysts, attract the other elements which are necessary in the particular process so that the end product comes into being.

The most complicated chemical processes, structures, and relationships are presented simply and clearly well within the comprehension of the layman and beginner in botany. All aspects of this fascinating subject are covered. The book can, indeed, be highly recommended to everyone.

ALICE HECKEL

SO YOU WANT TO MAKE A COMPOST PILE

PETER ESCHER

Compost can be made in large quantities for industrial purposes, by the farmer himself for home consumption, or in small quantities for the gardener. In all cases there exist innumerable directions regarding "How to make a compost pile." The difficulties encountered are similar regardless of size. If the materials are fairly much the same in both instances, then the question of whether a pile is to contain 2 cubic yards or 200 changes relatively little in the making of it.*

The methods of handling do change considerably if machinery is to be used. This is necessary if wages are high, efficient machinery not too expensive and costs of chemical fertilizers relatively low. The farmer and the truck and fruit growers have to compare their costs of composting with the cost of chemical fertilizers. This is one of the basic costs that determine the selling price of the crops or produce. The two direct considerations are the making of compost as inexpensively as possible and, particularly, the making of as high a quality of compost as possible.

The low cost of chemical fertilizers has had some unexpected results on the thinking of the grower, particularly the commercial grower. He was led to believe that fertility could be purchased in bags. His very concept of the fertility of the soil was changed from the original idea that fertility had to be carefully

* This article pertains to compost made with the B.D. Starter.

nurtured to the idea that the crop yield has to be maintained by adding more and more chemical fertilizer. As a result, the idea of composting was discarded, the spreading of manure looked upon as a way of disposing of a waste material. The ever-growing canning, freezing and food processing plants are faced with the same problem in regard to their disposal of organic waste materials.

Then there are some people who consider that compost piles are not necessary, that fertilization can be achieved by mulching. The primary purpose of a mulch, however, is to keep the weeds from growing and to maintain the moisture in the ground. The materials used for mulching are generally straw, hay and other inexpensive materials containing a lot of cellulose but few plant nutrients. The author has seen land mulched with other materials such as fresh manure and even garbage. The odors were such as to keep him from lingering too long. Such decomposition also tends to produce an uneven growth in the different parts of a field or garden patch, and meantime the sun has been leaching out the largest part of the fertilizing value of the material. At the same time, the moisture next to the soil can produce a growth of fungus if the manure or garbage mulch is too heavily applied.

One really mulches in order to increase the surface area with a loose material. There is a differential between the temperature directly above a mulch and that underneath it. It is this which creates condensation and adds moisture to the soil. The same principle is in use in many areas where dry land farming is practiced by cultivating the soil deeply and often to keep it friable, thus preserving moisture.

The fertilizing value of mulching material is generally not sufficient to meet the needs of the land.

The purpose of composting is to prepare the fertilizing materials in such a way that they are of the highest value possible for soil and crop. After all, we prepare our own food for ourselves and do not, for instance, eat carrots with their tops, feeder roots and attached soil as they come from the garden. It has even been reliably reported that most people *cook* their potatoes one way or another before eating them.

All of this is not to say that one should on no account ever plow in fresh organic materials. Plowing under is indeed feasible in some cases and for certain materials, if the soil is given a chance to break down the materials plowed under. The purpose of composting, however, is to use the materials available

to the best advantage. At worst it may take a little longer in the beginning, but it pays off in the long run when the soil is improved by making and using as good a compost as possible.

In the making of a pile, the directions read: Take a shovel, use your elbow grease, etc., etc. The *first* problem really is, where to place it. That depends on climate and your terrain.

What really goes on inside a compost pile? If you are looking at a good pile, you will notice that after you take off the top few inches it feels cool, cooler than the top layer because there is more moisture. To help in keeping a pile moist, we should not expose it to the sun or drying winds. Direct sunlight should be avoided wherever possible. A thoroughly finished compost should smell and feel somewhat like the soil beneath the leaves in the woods.

The location selected for the pile should also be well drained. Trees such as White Birch can be beneficial for the pile, but care should be taken to protect it from their feeder roots as well as from weeds. Under a large tree the feeder roots grow mostly near the crown drip, less near the trunk. Piles can be placed near the trunk of a large tree, provided they are not left there too long.

Most gardeners do not need any machinery in connection with their composting. However, if the gardening is on a large enough scale to grow sufficient vegetables to feed a family the year 'round, then a compost grinder may be advisable. The difficulty in grinding is that there are many different types of materials to be run through the same machine. Dry materials are relatively easy to grind; wet materials have a tendency — and sometimes a very annoying tendency — to pack. Some materials, such as cornstalks, have to be cut rather than ground. If a cutting grinder is used, care has to be taken to avoid such things as stones and bones. The hammermills, or impact grinders, easily plug up with manure and have to have such material fed to them carefully to avoid this. They can be used for larger operations, where the quantity of stuff to be handled warrants the investment.

The most indestructible tool to use for smaller quantities is a concrete mixer — bulky as even a small one is. The various materials, soil and all, are put together, along with sufficient water if the mix is too dry. The mixer is run about 15 to 20 minutes per batch. The Starter is added after about 10 minutes.

The moisture can be controlled very accurately by observing the material. The mixture forms balls. If these are small, water should be added until they are the size of a child's fist or a horse-dropping. If they are larger than that, the mixture is too moist and shredded paper, dry soil or some other dry, moisture-absorbing material can be added.

If machinery is used in connection with composting, and the available soil contains a lot of stones, it is preferable to screen it first. If stones are a bother when composting by hand, the soil can either be screened to start with, or they can be taken out as one goes along.

If large quantities of compost material have to be handled, mechanical processing has its advantage, in that the compost will be ready sooner and the storage period is reduced. In a small garden, the storage problem is generally not such as to warrant the use of machinery.

It is essential to spray the Starter over the materials as they are ground (sprayed over the succeeding layers if it is a hand operation). This permits the Starter to be evenly distributed all over, and gives the bacteria a chance to do their work quickly and effectively.

The materials available to be used for composting vary tremendously from place to place, with the exception of one: that is soil. It is advisable always to use some soil, along with other materials, when making compost. The mixture is broken down more quickly, and the structure of the product is improved. If soil is simply not available for the purpose, one can substitute a reasonably well-finished compost.

What kind of soil is to be used? The first thought generally is of subsoils, but these are poorly aerated and generally devoid of soil life. A good topsoil makes for a better compost sooner. The problem is generally, where to get the topsoil. It is preferable to make piles on bare ground, first skimming off the surface growth and some soil — this gives you a little to work with. Sometimes it is possible to take some out of the garden if it needs drainage (a ditch) or levelling. Often real estate developments sell some topsoil; sometimes farmers do so. In one case I knew of, a garden was over-run with honysuckle. Here the topsoil was shaved off with a bulldozer and piled up until the roots had broken down.

A good loam is the best soil to use in a compost pile. A sandy soil is a bit too porous. If only one could obtain clayey soil for

composting in sandy regions, and vice versa, that would help the gardens very much in both places. In no case should the very finest colloidal clays — that is, those that accumulate at the bottom of a lake or in canals and the like — be used in composting. The particles of these are so fine that they enter the pores of the other materials, exclude air, and do not permit the bacteria to do their work.

How much soil is to be added to a compost pile? By weight, a minimum of 10%, preferably more. It is possible to get away with using so little in the case of mechanical handling, as this permits a more even mixture of all the materials. Loose soil weighs 80 lbs. and more per cubic foot, whereas a wettish manure weighs about 50 lbs. per cubic foot and garbage anywhere from 15 to 35 lbs. per cubic foot before grinding. As the weight of anything per cubic foot varies with the looseness of the material, we prefer to figure the percentages in weight rather than volume. The remaining variable is the moisture content.

That brings up the moisture problem. How moist should a compost pile be? There should be 50 to 60% moisture during the composting itself, with the figure reduced to 40 or 45% when the pile is finished. It is not feasible to test the moisture of the various materials going into the pile, so in practice one adds moisture or adds dry materials, as noted above. Remember that a material containing 25% moisture is one fourth liquid and three fourths solid; 75% moisture means only one quarter of the material consists of solids and three fourths of it is liquid. While it is relatively easy to add water if a pile is too dry, it is by no means as easy to balance the situation if it is too moist, particularly in a moist climate. The "dry" materials you add also contain a certain percentage of moisture. Paper, for instance, can have a moisture content of 25% in a moist climate. You can very soon get into some complicated mathematics.

There are some simple rules that can be of help, particularly for the setting up of smaller home-garden piles. If the materials you want to use are too moist, use more soil. Try to put the moist material on top of the pile to give the moisture a chance to drain. Wet materials are heavier per cubic foot, so you need, by volume, more dry materials to balance them out. Mix your wet materials with loose materials, to permit any surplus moisture to drain. If you live in a moist climate, try to keep some dry materials on hand. Keep the soil you are going to use in the pile covered with a tarpaulin, tar paper, or Vis-

Queen (Visking Company, Terre Haute, Indiana), which costs 1.5 to 3 cents a square foot, depending on its thickness. This latter, by the way, can also be used for mulching. When dry, an absorbent material (such as paper, or Staysdry, a material used for chicken litter) can take up a lot of moisture; when it is once wet it has the opposite effect. To find out whether soil is too wet or not, take some in your hand and close your fist and then open it again: if the soil crumbles loosely it is dry, if it balls up it is too wet and should not be used or worked with in that state.

Many materials can be used for composting—see the Spring, 1954 Issue of Bio-Dynamics. These materials are of either animal or vegetable origin. As a whole, those of animal origin have a higher nitrogen content. Remember that most of the vegetables, and many flowers and berries, are nitrogen-consuming or soil depleting plants. Sufficient nitrogen has to be supplied for a vegetable garden to at least maintain its fertility. If no raw materials of animal origin are available, a considerably larger quantity of vegetable raw materials has to be used.

The most used materials of animal origin are, of course, the manures. A compost pile should contain from 10 to 20% manure. Cow manure is the most used, and the most important for a balanced fertilization. If cow manure is hard to get, a solution of one part manure to 100,000 parts of water can be sprayed over the mixture. Poultry manure is higher in mineral content than cow manure, and makes for a more rank growth. It is more desirable for corn than for root vegetables.

Poultry manures are difficult to compost. They have to be well mixed with soil and other materials to break down. Poultry manure with litter is much easier to handle than roost or battery droppings. The litter provides air spaces between the droppings and keeps them from packing. Horse manure has a tendency to heat up. It generally contains a lot of straw. When using horse manure care should be taken that there are not too many air pockets in the pile.

In the garden itself, the most common raw materials for composting are the weeds. It is preferable to pull them before they go to seed, to avoid growing a new crop of weeds from them. In the pile itself, if it is large enough, there is apt to be sufficient heat generated to destroy any weed seeds that might have gotten into it. But please do not simply pile up a lot of weeds and call the result a compost pile.

Lay the weeds down in a layer, spray the Starter over it, and cover with a little soil. A layer should not be over 2" thick. Household garbage can be composted in the same pile with weeds. The latter are often too dry, while garbage can be quite wet. Care should be taken to spread the garbage out well, and cut up the larger pieces. This can be done with the edge of a shovel. Suppose for instance there is an apple in the material you want to compost. If it is sliced, even once, the bacteria can attack the inside of the apple. If it is not, their progress is retarded by the skin and its waxy coating. Paper will break down more easily if it is shredded or torn — something that can be done by hand. A compost pile made with garbage, or with many different materials, can be used when some or most of the materials are ready — taking out and re-composting those that have not decomposed.

Leaves take a very long time to compost if they are not ground. When shredded and mixed with other materials, they will break down very readily. (Note: in all cases the mere breakdown is not sufficient, time must be allowed for the upbuilding bacteria to develop the material into a good, usable humus). On whole leaves, the waxy coating delays the bacteria in getting at them. If no shredder is available, leaves can be composted with some soil and a little lime. The result, in a partially broken down condition can be used as a mulch, which will gradually break down. The value of leaves as a fertilizer is not very high from a mineral point of view. They do, however, contain trace elements, and some tannic acid, which is not relished by beetles.

Market leftovers can provide a good supply of materials for composting. Chicken entrails, fish cuttings and the like, are excellent. It is to be pointed out that they have to be handled carefully. Mix with other materials that are absorbent, and use plenty of soil. If you want to keep your neighbors from asking what kind of a perfume factory you are running, spray the Starter in a fine spray over the materials, and ascertain that each particle has been sprayed. Such raw materials may be sprayed a couple of times when they are dumped preparatory to setting up the pile.

Sewage sludge should never be used uncomposted. Properly treated, it can be a reasonably good fertilizing material. Some people do not particularly relish handling it. Unless it is carefully prepared it is preferable to use it for flowers and ornamental bushes rather than for vegetables.

The remaining materials for composting are those that contain mostly cellulose. Peat moss generally has a mediocre fertilizing value. It can be slow to break down, but it absorbs a lot of moisture. Wood shavings can be broken down, but the process is slow and the result has little fertilizing value. Sawdust can be too fine, in which case the same difficulties are encountered as with a fine clay.

Compost materials should be mixed in such a way as to obtain a carbon:nitrogen ratio of from 1 to 8 to 1 to 20 or a little more. Thus, for instance, wood shavings, which have a C:N ratio of 1 to 40 could be mixed with chicken droppings if not enough paper or other cellulose is available.

In order to make a pile, the following tools are required: shovel, pitchfork and horse sense.

It is, as stated previously, preferable to make the pile on bare earth. Skim off the top and pile this soil on the side for use in making the pile. If you have a thin topsoil and your pit is therefore in subsoil, put some topsoil on the bottom before starting to layer in the compost material. The farther South you live, the deeper the pit should be. In Northern New England the pile should be practically on the surface. In the deep South the pit should be 1½ feet deep. In a heavy soil the pit should be less deep than in a light, sandy soil. The purpose of making a relatively deep pit is to help preserve the moisture in the pile. If a pile dries out, nothing happens in the way of producing compost. If it is too wet you have troubles too.

If conditions make drainage desirable, you can dig a trench lengthwise in the pit and stuff it with branches and boughs. A hole dug at the lower end of the ditch, just beyond the pile, will, in a heavy soil, collect the excess juices which can then be poured over the material if it gets too dry.

The shape of the pile should be an oblong pyramid with the top cut off. Length can be as desired. The other dimensions, if sufficient materials are available, can be up to 12 feet wide at the bottom, 4 feet high and 6 feet wide at the top upon completion of the piling up. In case wet raw materials are to be composted, it is advisable to make the pile less high and proportionately less wide. For instance, not so long ago we composted some poultry manure with soil, garbage and paper. It had been raining, no dry materials were available, yet the materials had to be composted then and there — the odor of the raw, fresh chicken manure was a cogent reason. The pile was made between 2½ and 3 feet high. Proper drainage was pro-

vided, and care was taken to aerate the pile. A very good compost was achieved without any turning of the pile.

In the old days, directions for compost heaps used to speak of layering. How thick should a layer be? By handling the raw materials with machinery we have learned that the mixture of a lot of different compost materials gives a better result than if different things are set up in layers separately as they come along. Thus in composts made by hand there can and should be quite a degree of mixing in setting up the horizontal layers. If cornstalks are used for a pile, lay them next to each other and not on top of each other, and put other materials in between. Do not — to put it extremely — pile corn stalks 4 feet deep, put a little soil on top and hope for the best.

Corn stalks, by the way, provide a lot of air spaces and so are best used in the bottom of the pile (drainage), while a predominance of more compact materials should go in the upper part where the air can get at them more easily.

Dolomitic lime can be used in making a pile*. On the basis of the author's personal experience, he only uses it when a pile is made with vegetable materials, to be used on acid soils. Whether the acid condition is cured depends also on proper tillage and handling of the soils. A light sprinkling of the lime is generally sufficient. By using the Starter, sufficient heat should be created to break down the cellulose materials for which unslaked lime was formerly used before the Starter had been developed.

The use of the B.D. Compost Starter; referred to as the Starter, is a great help in the making of a pile. It speeds up the breakdown, and the development of soil bacteria. A pile made by hand (layered); takes, with use of the Starter, roughly half the time such a pile would otherwise need. If it is properly handled, the quality, where the Starter is used, is also higher than it would otherwise be. Most of all from the point of view of time and labor, there is the factor that piles do not have to be turned as often. In fact the author has found it very rarely necessary to turn a pile made with the Starter, even in cases where the pile was too wet to begin with.

In order to give the Starter a chance to do its work to best advantage, the directions should be followed: Reactivate the Starter by moistening, the day before, as much of it as is to be used. Dry Starter keeps several months, and can be left in the original container or in a jar, but preferably not in direct sun-

* This lime has a higher magnesium content than ordinary limes. Magnesium is a minor element important as a fertilizer.

light. It is reactivated best at room temperature. The Starter solution should be sprayed reasonably finely. If the nozzle plugs up, take it off and hold your thumb over the opening to get a spray effect.

It is most important that the Starter solution is well mixed with the raw materials. When the compost is made with machinery, the Starter solution is, as previously noted, sprayed just before the grinding. This permits a thorough mixing of raw materials and Starter. The Starter is diluted with water at a rate of 2 to 5 gallons for one unit of the dry material. This is enough to treat 1 ton of raw compost materials. As a rule of thumb one can figure 1 ton of a moist material to equal about 1½ cubic yards.

Do not pack a compost pile while you are making it. If it is too loose that may be because of insufficient binding material such as soil or manure. If the material is too wet, and a board is used for getting onto the pile with a wheelbarrow, the area under the board is compacted and air is excluded from this part of the pile.

To test whether it is necessary to aerate a pile, put your foot on the side of it and press gently. If the resilience is very low, the pile is too compact and needs aeration. In severe cases it has to be turned. Otherwise holes can be punched into the pile, using either a crowbar or a discarded rake handle that has been pointed. The holes should be made right down to the bottom of the pile, and placed from 6 to 12 inches apart, depending on the need for air. Push the tool all the way in, and, while not widening the sides of the hole unnecessarily, make sure that the hole is not plugged up. This procedure may have to be repeated.

If a sufficiently large pile — say 2 or more cubic yards — is set up at one time, it may heat up. The temperature should not be allowed to rise above 140°F. A special compost thermometer can be used, or a small hole made and a dairy thermometer inserted — or you dig out part of the pile and touch it with your hand, or put a steel pipe in the pile and leave it there for a while. If material or pipe are definitely too hot to touch, then the pile is too hot. To reduce heat, ventilate. If the pile is too dry and you are not getting rain, add water.

While making a pile, keep its form in mind: an oblong pyramid with the top cut off. It is preferable to cover a pile all over with soil if there is enough available. In that case the sides should have an angle of about 45°. If not enough soil is available, then in a hot climate it is advisable to cover the pile with

corn stalks or straw or whatever can be obtained, to maintain the proper moisture and to permit the outer and upper parts of the pile to go through the decomposition process instead of drying up.

When a pile is finished, check it about a week later. If you are in a hurry for the finished compost, repeated checking is helpful. It is preferable not to disturb a pile during the initial heat period. The heat of a pile starts to rise when it is made, remains constant for some 4 days, and has dropped by the tenth day. This initial temperature is independent of the outside temperature. If a pile is to be turned, do it after the tenth day or later.

Take care in making your pile to do it with care, so as to avoid turning as much as possible and thus not have double work.

If a pile is made by machine, it should be kept intact for at least three weeks to give the nitrate forming bacteria a chance to develop. If the pile is made by hand the whole process takes considerably longer. Often parts of such a pile can be used and the rest re-composted.

If compost is to be stored, it can first be spread out to dry.

Compost with a high nitrogen content and in a relatively raw state can be used for corn. Most crops, however, prefer a thoroughly broken-down compost. Compost that is a year old can be used as is for flowerpots, without adding soil.

NATURE'S WONDER DRUG

RUTH EASTMAN

In the American Bee Journals of January through May 1952 there is a series of articles written by D. C. Jarvis, M.D., of Vermont, which I found most interesting. Perhaps my interest stems from the fact that I keep bees and I like honey and would not object at all to taking it as medicine any time my own doctor cared to prescribe it. Dr. Jarvis relates how he and three other ear, nose and throat specialists were attending a meeting of the American Medical Association and got into a discussion out of which there developed a plan to set up a correspondence study group among themselves. Dr. Jarvis became the coordinator of the group and each week sent to the members a mimeographed report of the letters he received regarding the clinical experiences of the other members as well as his own studies and ex-

periences. In a short time the group grew to include fifty members.

As the years passed, new frameworks of medical reasoning were developed. After twenty years eleven new frameworks had been added to the original four with which they had begun, and to me it was astounding to find that honey played a part in the treatment given or recommended by Dr. Jarvis in many illnesses.

Dr. Jarvis suggests honey when there is a vitamin deficiency. In endocrine gland disturbances, honey can be used as a body sedative. In cases of a potassium-calcium imbalance honey is prescribed for the potassium which it contains. Honey by mouth will lower the blood phosphorus level. If an increase of daily intake of carbohydrates is needed, honey is prescribed. Dr. Jarvis reports that honey contains many of the trace elements. He also says that Mother Nature believes in the law of the minimum, and that if the human body receives a minimum of the elements it needs it will function properly. Dr. Jarvis ends this series of articles by stating that nature's source of natural antibiotics is honey comb cell cappings.

In an article written for the American Bee Journal in December, 1951, Dr. Jarvis gives the history of the treatment of a small boy suffering from a severe case of whooping cough. The child had received the usual medical treatment but the coughing, vomiting and whooping continued. Dr. Jarvis gave the child a "chew" of the cappings and the coughing stopped. Another "chew" was given early in the evening and the child slept all night. Within ten days the child had recovered from the disease. It seemed necessary to give only three "chews" a day to keep the symptoms under control. Dr. Jarvis suggests that mothers keep a jar of the cappings on hand to be used in controlling severe coughing even from causes other than whooping cough. He goes on to explain that at that time no one had as yet discovered what it is in the cappings that is so effective on the breathing tract, but perhaps sometime someone will discover a method of analysis that will reveal the factor.

In 1954 the same author wrote two more articles, entitled "Be Kind to Your Heart." In them he states that in his home State of Vermont the weather is very changeable, which makes it necessary for the skin to "one day be a radiator giving off heat and the next day an insulator conserving body heat." This puts a strain on the heart. Vermont Folk Medicine has learned that

honey contains potassium, which aids the circulatory system and makes it easier for the body to adjust to the many changes in temperature. Truly it seems that honey is nature's wonder drug.

GROW VETCH, YOUNG MAN — —

R. A. ARNDT

Mrs. Arndt, who farms in the Ozarks, near Hillsboro, Missouri, is a Biodynamic Farmer of long standing. Readers of this Quarterly will remember some of her earlier contributions. We welcome her back to these pages with enthusiasm, and look forward to hearing more from her.

* * *

The fervent wish of Faulkner for the American farmer, "May his income decrease, to the ultimate profit of the whole American people, including, first of all, the American farmer," has been fulfilled. Whether we shall learn our lesson is beside the point. Even at the very worst, there are still available effective means of restoring life and fertility to the soil, and we heartily recommend the method of one Ozark hillbilly farmer who is still too proud and tenacious to "go west, young man."

In practice, the idealistic farmer always has soil in the bank; at the present time ASC cost-sharing may be applicable in areas where organic methods are not yet penalized. Locally however, a practice is reported completed by submitting the receipted bills for the chemical fertilizer used in establishing the practice!! No receipts, no cost-sharing!

A marginal field — and we have in mind a field for which manure cannot be spared for another 2-3 years — such a field can be revitalized with great economy of cost and effort by letting vetch and bees do it for you. Inoculated hairy winter vetch is seeded with rye (about 2 peck vetch with 1 peck rye per acre) in late summer in a prepared seedbed. In this instance the field was plowed in midsummer and allowed to weather. The vetch is tolerant of acid soil and requires no great fertility. It makes enough early growth to provide ample winter cover, *and* it reseeds itself so that the field may be kept in vetch for several years with no more effort than a once-over with the disk harrow in late summer to incorporate the seed with the trash. The ripe seeds will shatter and, in a normal summer, lie dormant for weeks. But the field should be watched, the plan being to germ-

inate it in late summer. A rainy season may germinate enough seed to make disking both wasteful and impracticable.

During the long blooming season the field is a-roar with honey-bee activity. Bumble bees too, work vetch with astounding enthusiasm. While walking near this field one day, musing on other matters, I looked up startled by a sudden windstorm; only to realize that the roar of the "windstorm" came from the vetch field, rising and falling on the breeze.

Standing waist-deep in this purple glory is one of the great joys of a Sunday morning in early summer.

Vetch honey is water-white, a fancy grade — as those things go — and it may be advisable to invite an outside beekeeper to make use of the flow. Vetch seed commands a good price, and a crop of it may be taken, still leaving enough shattered seed for the next year. Because of the long ripening season, the crop should be windrowed when a fair amount of seed has matured.

The re-seeding virtue of vetch makes it a weed in grain crops; so, when going on to the next stage of the rotation, one should incorporate it in the soil as a green manure crop, with the B.D. Compost Starter, before any seed has ripened. Rudolf Steiner said that green manuring encourages leaf growth, so a transition to herbal meadow mixture is a logical one, and one in which the appearance of a little weed-vetch has no serious objections. Cattle do graze it, but with little enthusiasm.

Seeded, as it should be, with a stiff-strawed grain, preferably rye, to support the clinging tendrils, this association has several soil-building advantages. These are borne out by experience. For instance, one field we know, in its second year, shows no run-off even under extreme conditions of slope and downpour. This dirt farmer is glad for the advice "Grow vetch, young man, grow vetch."

THE POWER OF AN AGRICULTURAL CIVILIZATION

RICHARD B. GREGG

Readers of Bio-Dynamics will be glad to know that we have heard from Evelyn Speiden, now Mrs. Richard B. Gregg. She sent us, from India, the following article, from an earlier book of her husband's "Economics of Khaddar" published some years ago by Navajivan Press, Kalupur, Ahmedabad, India. While the work was addressed primarily to an Indian audience, the editors feel as she does that it should be of interest to B. D. people in connection with the basic question of the importance of agriculture for the stability of a civilization.

Mrs. Gregg wrote that she is currently working on an article for Bio-Dynamics "about the amazing land movement that is taking place in India today". Regarding the piece by her husband she noted:

"'Khaddar' or 'Khadi' is a term applied to handspun and handwoven cloth, long a symbol during India's struggle for independence, now the most important of many of the village industries being revived". The book in question is now being revised for a third edition.

She wrote further:

"We are living in one corner of one quadrangle of Gandhigram, which is a collection of schools of more varieties than I have yet gotten straight in my mind. This section is for extension students, a five-months course for those who already have college training in many cases and are to be leaders in village work. They work in English because they come from all over India, 60 to 80 of them, and they cannot understand each other's dialects. So we can talk with them more easily than with most of the other students, even though more English is spoken in south India than in the north. Gandhigram is in the center of the point of India, about the lattitude of the northern tip of Ceylon.

"Our quarters are one large room (about 22 by 14 feet) and one adjoining room of half this length with the other half a porch. Floor, and walls to about 7 feet are cement; above that the high-peaked roof of thatch supported on bamboo poles, no ceiling. This is the coolest kind of roof, but begins to leak some towards the end of its 3 years of life, which is where ours is now. Water supply is one tap in a little 6 by 6 bath room outside the back door. Toilet is around the corner and contains another tap. Electric lights in all rooms, rather recent innovation. My kitchen is some small bench-tables in the corner nearest the bath room water supply. We have an electric hot plate and a Primus (kerosene) stove. Usually one or the other will work, but I get only breakfast and supper. We endure one "hot" meal a day in the student kitchen."

All physical power is derived ultimately from the sun. Coal and petroleum are, in effect, reservoirs from the stream of the solar energy of past ages converted and stored up by vegetation. Water power comes from the action of sunshine evaporating water from the oceans and transporting it to the land and rivers in the form of clouds and rain. Even the mechanical

energy of horses and cattle, and man himself comes from food obtained from plants activated by sunshine. All the power used in modern industry and in the economic activities of man in past ages came from his using some part of the never ending stream of solar energy. Any scheme which utilizes and efficiently transforms solar energy to a greater degree than was being done before is sound, from an engineering standpoint, and also from an economic point of view.

What does this solar energy really amount to?

We will examine it in detail, not to argue that it can be fully utilized, but because we all need to correct our perspective on the problem of power in modern industry.

The article on "The Sun" in the Encyclopedia Britannica (11th ed.) states that the units of solar energy received per minute per square centimeter at the earth's mean distance from the sun amount to 2.1 calories, or at the rate of 1.47 kilowatts per square meter, or 1.7 horse-power per square yard. More recent researches in astrophysics modify these figures and indicate that only about 0.6 horse-power per square yard, on the average, actually reaches the earth's surface.

Another author describes it as follows: "Let us see if we can get some idea of the energy the sun expends. The valley of the Mississippi is reckoned as having an area of 982,000 square miles, and on each square mile there falls every year about forty inches of rain. Now, the coal that would have to be consumed to evaporate a body of water one mile square and forty inches deep would be 182,000 tons. The coal, therefore, that would be required to evaporate the rain that falls in one year on the Mississippi Valley would be 178,724,000,000 tons. The output of coal for the world in a year is only a little over 1,100 million tons, so that to evaporate enough water to supply the rain of the Mississippi for a year would take 150 times the world's annual coal supply."

The solar energy falling on the area of India in one year would be, roughly, 58,601,685,904,000,000 horse-power. This would be equivalent to over 207,000 times the horse-power obtainable in better than ordinary practice from all the anthracite and bituminous coal mined in all the world in the year 1927. (Based on an assumed average of eight hours a day of sunshine and an engine and boiler efficiency yielding one horse-power per pound of coal burned.)

The current supply of energy from the sun is thus amazingly greater than our resources of coal and oil. *This* is the real

source of the material wealth of India. We do and can use only a minute fraction of it, but to disregard available means of utilizing it is clearly un-intelligent and un-scientific. . . .

The Statistical Abstract for India (including what is now Pakistan) for 1930 gives the net area actually sown to crops. . . . To this area we would add the remaining land capable of cultivation, as well as the forests, in order to get the total possible productiveness of vegetation, . . . allowing an estimated deduction for fallow proportionate to current practice. This amounts to 489,324,610 acres. This we may call the potential agricultural area of India.

We have seen that the solar energy falling on each square yard of the earth's surface is, on the average, 0.6 horse-power. Various researches have shown that plants are able to transform and use only a small percentage of the solar energy received by them. The different experiments gave figures ranging from 0.6 percent to 7.4 percent. Let us take 1% as a conservative figure, for the scientists are not yet agreed on the amount. That 1% is the rate of possible conversion of solar energy into vegetation. Remembering that there are 4,840 square yards in an acre, let us multiply the above area figure by 4,840 and then by 0.6 and then take 1% of the result. . . . We find that the total solar energy convertible into vegetation on the potential agricultural area of India is 1,420,998,667 horse-power. In making these estimates we are disregarding deficiencies of water, lack of fertilizer, defects of practice, etc. We are trying to find the amount of energy available if everyone were heart and soul determined to get it so that they removed all obstacles.

How stupendous these figures are is shown by comparing them with the power of the engines used in two of the leading industrial countries of the world. The United States develops and uses much more physical power than any other country in the world. The U. S. Geological Survey, estimates that all the "prime movers" in the United States in 1923 developed 662,600,000 horse-power. This includes all the engines and turbines (whether steam, water power, oil or petrol motors) used in manufactures, in all motor cars and land and water transportation of all kinds, mines, agriculture, electric power plants and irrigation. The U. S. Government Census tells us that in 1927 the total prime movers in manufacturing in the United States had a rated capacity of 38,825,681 horse-power. According to

the 1924 census of production in Great Britain, the total specified capacity of all prime movers in the factories and plants of that country was 11,037,000 horse-power.

Comparing these figures, we find that the solar energy convertible into vegetation on all the potential land of India is over twice the power of all the prime movers in the United States; about 36 times greater than all the total manufacturing power of the United States; and about 129 times the total manufacturing power of Great Britain.

Let us see what this might mean to the individual farmer. Apply the figure of 0.6 horse-power of solar energy per square yard, and 1% efficiency of conversion by plants, to a little ten acre farm. We find that its proprietor is in charge of a solar power plant with an average power income of 290 horse-power available for transformation into vegetation, assuming adequate water supply. The wealth is there if means can be devised for taking it. The energy available to a three-acre farmer would be 87 horsepower.

In the light of these figures it would seem that, contrary to the prevailing assumptions, agriculture is far more important than power-machine manufacturing, as a source of wealth. Solar energy exceeds energy from coal, oil and water power in almost every country. Also solar energy is annual income, but the energy from coal and oil is in the nature of capital and when used can never be replaced. Agriculture is more important not only to the human race and to the Indian nation as a whole, but also to the individual common man.

From plants and trees come directly or indirectly all our food and all our clothing, much of the heat used for cooking in India and other countries also, some of the heat used in small manufacture in such countries, an important part of the material used for buildings and furniture and many appliances, and the fibres used for ropes, twine, sacks, parcel coverings, baskets, boxes, and paper of all kinds. With the modern developments of the chemistry of cellulose, there is an immense range of new products which can be made from vegetation as the raw material. If wealth consists of the physical requisites of life, then agriculture supplies a very large proportion of our wealth. This is perhaps more true for tropical nations than for those in temperate climes.

The agricultural landlords of many countries have an inkling of the meaning of the foregoing figures, though not expressed

in those terms. So also do those nations who desire to use the tropics chiefly as markets and sources of raw material. It is perhaps the major material task of the common people of each country to take and keep this power for themselves, free from overlordship or alien control of any kind, and to develop it to the uttermost.

Our financiers and industrialists have been apparently misled by the somewhat spectacular results of industry, and have overlooked the greater though less showy possibilities of agriculture. It would seem that the peasant is not so stupid as many city people seem to think. We are thus given grounds for believing that village life is more important than city life,—closer to the great sources of material power. Farming appears to be the most important branch of engineering. The value of irrigation works and of all agricultural reforms stands out more clearly. We see how great an interference with the productiveness of the country comes from landlordism and heavy land taxes. When the great bankers and political rulers of Great Britain and United States determined to abandon their support of agriculture, and instead to devote the national energies to industry and foreign trade, they made a mistake. (Editor's note—This is far more evident today than when this book was written.) France has been wiser in keeping a better balance between agriculture and industry. A sound balance between industry and agriculture would lay the emphasis on agriculture, and would give it the favored place in financial assistance, in education, in economic, political and social esteem. These facts should be a stimulus and encouragement to agricultural experts and to those who are working for the economic and social improvement of villages and rural tracts. Professor Soddy, from whose book we quoted before, said that "Progress may be regarded as a successive mastery and control over sources of energy ever nearer the original source." That original source is the sun. We have always known that agricultural civilizations are stable. In view of the foregoing facts we now see that an intelligent agricultural civilization is not "backward" but is wisely progressive. Denmark is an example of this.

There is reason to believe that, under the influence of science chained to capitalism, the material social environment in Western industrialized countries is perhaps changing so rapidly that not only is the stability of society threatened, but also it becomes impossible to understand how the changes will act;

that is to say, impossible to use foresight. Developments under such conditions are not progress but an uncontrolled blind movement that may end in destruction. If power is to be useful to mankind, it must not be just an eruption and rushing storm, but it must be understood and under some sort of wise direction and control.

A LETTER FROM INDIA

Just as we are going to press we are delighted to be in receipt of a new letter from that personal friend of all B.D.ers, Evelyn Speiden Gregg. As you will see, it is really addressed to all of you:

Fellowship Ashram, Kodaikanal, Madras State, India, May 22, 1957.

Such an interesting evening as we have just had, I want to tell you about it at once — for Bio-Dynamics if you wish.

We are still in the mountains, and attended the University Women's Pot Luck Luncheon at Kodai last week, where an Indian friend from Gandhigram was the speaker. There's so much going on in the town this month that I should think the folks who come here for a vacation would need another when they leave. The Ashram where we are is four miles out and more quiet. Just now is the hottest season all over India — hot and dry. We came up to Kodai March 12th to escape the increasing heat. By mid-June, rains are expected to cool things somewhat. Here, of course, at 7,500 feet altitude the climate is delightful, sunny warm days and two-blanket-cool nights.

The group of Ashram buildings — ancient, lacking in comfort and attractiveness; and the garden — altogether lovely; are just a few hundred feet back from the long line of cliffs where one looks down over a mile to the plains, a view rivalling that into the Grand Canyon. It is hard to realize how hot it is in the scores of villages scattered as far as the eye can see (about 100 miles in clear weather), shining like jewels when their new electric lights go on at night. Surprisingly many of the tiny squared fields — those near enough to irrigation waters — are bright green between the larger areas of rust-colored soil. Nearby lower hills too, are velvety green. The view is southeast with the most wonderful cloud effects I've ever seen, usually above, but sometimes below in the mornings when the sun rises over a sea of cloud-waves covering the whole plain. Then too, the mists

rise thickly and very fast, usually in mid-morning, rolling like white smoke up over the cliffs and into our garden. Sunrises and sunsets, approaching storms, rainbows, fog or rain curtains revealing vistas of distant golden sunlight, — all these and more, provide infinite variety and constant change, so that one could spend hours just watching from the cliff.

It is seldom that we do, however, for Richard is still working on the revision of his book, "Which Way Lies Hope?". I'm trying with some success to get long-delayed reading and writing done. There's so much "fellowship" here that it takes much of one's waking hours. Since both of us were used to living alone, we find it rather overwhelming at times.

Among the forty-odd persons here, coming and going, are Indians, Japanese, an Argentinian, a Persian, Irish, British and Americans. The evening we enjoyed so much recently was spent with an American doctor and his Japanese wife, her sister who is a nurse (both of them Hawaiian born and American college graduates) another unrelated Japanese man, a scientist, and the keen young man from Argentina. This group came here from Sevagram, in north central India where Gandhi once had an Ashram. Now it is an educational center attracting young people from all over India. We shall be visiting there next winter. They've been doing public health work, research and practical composting with some gardening. Maeda, as everyone calls the Japanese scientist, showed us some composting charts, giving results of their research. They were made to take to the recent conference of Bhoodan (land gift) workers. Maeda plans to stay in India, and his sister and mother are soon coming to join him. But he has been here only a year and is still struggling to learn both Hindi (the official Indian language of the future) and English, so Mrs. K. had to translate most of the conversation.

It seems that over 30 years ago the Japanese Government began taking an interest in composting, and giving each farmer financial help to build a compost house such as they advocated. Now nearly every farmer has one of these houses made with foot-thick mud walls and thatched roof. A house is about 10 feet high, perhaps 10 to 12 feet wide, by 18 to 20 long, and dark inside so the compost is well protected from drying sun and wind. They dig no foundations, but build the piles on the bare earth and nearly to the roof, leaving them there until the compost is wanted. Maeda is very much against the Indian practice of

making little piles of finished compost here and there in garden and field, and gradually spreading it out on the surface. He says this is wasteful, that the precious stuff ought to be mixed at once with the topsoil to protect it from drying out, which happens soon under this Indian sun.

Dr. K. and Maeda are reading with great interest Dr. Pfeiffer's Compost Manual and our Bio-Dynamic literature, and are going to use some of the B.D. Starter Dr. Pfeiffer gave us to bring out here. Maeda's training has been in bacteriology and botany and he has collected plants over most of Japan, Korea and Manchuria. So it looks as if we may, at last, have found a center from which good composting methods can spread widely with the students who come and go. The couple who have been carrying on at Sevagram since Gandhi left are old friends of Richard's and much interested too. Mr. Aryanayakam and his wife Asha Devi have both traveled widely outside as well as within India and are now giving much time to Vinoba Bhave's Boodan work — more of this later.

Composting of a great variety of hit and miss sorts is widely practiced in India, but it is only a drop in the bucket compared to what ought to be done. One of the first things Richard did in India last fall was to write a requested article for the Gandhi Marg, official magazine of the Gandhi Memorial Trust. He chose the subject, "A possible help for the Indian Scavenger." Although caste lines are disappearing in India, they are still often found in rural districts where 323 million people, 83% of India's population, live in 588 thousand villages. Among the most looked-down-on people are the scavengers or removers of night-soil. Gandhi and many other Indians have worked valiantly to improve their economic and social status. If scavengers could become the trained and efficient composters of India by using the materials they collect, an immense waste of both material and human values could be transformed. Figuring probable amounts, the total might well be 40 million tons per year of compost for all of India, a "cash crop" for the scavengers and a boon to farms and gardens where organic fertilizers are scarce.

Not only here but throughout the Orient, the safe utilization of the immense collections of night soil, so often wasted or wrongly used, would be of incalculable value in both material wealth and health. By working out this problem in a creative way, India might thus be contributing not only to her own welfare but to that of far more than half of the population of the earth.

Two articles I have in mind to write for Bio-Dynamics — one on Vinoba Phave and his Land Gift Mission, the most evolutionary agricultural movement in the world today; the other from a report of a recent agricultural mission which went to China from India. The leader of the mission sent us a copy of their official report which is of great interest as news from within China by disinterested parties, who seem to have had a very free field for observation.

Besides collecting rocks that look interesting, getting an acquaintance with Indian birds and plants, I'm making an effort these days to prepare for our travels by acquiring a background knowledge of Indian culture, art, religion and history. Nehru's book "The Discovery of India," written for his daughter while he was in prison with a number of Indian scholars, is a great help. So far I've seen little of the country, as we stayed at Gandhigram until we came here. But in late August we shall start with Cape Comorin on the southern tip of India and the new State of Kerela stretching from there up along part of the west coast — said to be the garden spot of India — and gradually work our way northward between lecturing and sightseeing. By next hot season we hope to be somewhere in the Himalayas. Then homeward bound on a freighter via Japan and California.

Mail sent here will be forwarded — and how we do enjoy it! I've been hoping to print a general letter for the many friends who have written us. Perhaps we will yet, but when the Ashram here closes, I'll have to start doing our cooking again, and that takes more time here than at home.

Meanwhile our cordial greetings to you both and to any other friends who may be interested in our doings.

As always,

EVELYN (SPEIDEN GREGG)

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